Chem 1420.403 / General Chemistry for Science Majors, 2nd semester

Instructor Information

Name: Stephanie Liu

Office Hours: T/Th 12:30 –2:00 PM @ CHEM 272, or by appointment on Zoom

Email: **stephanie.liu@unt.edu**

Course Schedule

There are no scheduled class meetings or recitations. All course material is posted on Canvas in Chem 1420.403.

Course Prerequisites

Grade of "C" or better in CHEM 1410 (General Chemistry I) or equivalent.

Course Corequisites

CHEM 1420.423 (recitation)

Course Description

Chem 1420 is the second semester of general chemistry for science majors. Topics include entropy and free energy, reaction spontaneity, solutions, solubility equilibria, acid-base equilibria, electrochemistry, kinetics and nuclear chemistry.

Course Objectives

Upon successful completion of this course, you will be able to (numbered in order of presentation):

I.   Review of relevant concepts in Chem 1
    1. Intermolecular forces
        a. Identify ion-dipole interactions, hydrogen bonds, dipole-dipole interactions and dispersion forces.
        b. Compare the strength of intermolecular forces
    2. Phase transitions
        a. Identify three phases in phase diagrams
        b. Identify three phases in heating/cooling curves
        c. Calculate the heat of phase transitions.
II.   Thermodynamics
    1. Entropy
        a. Compare entropy according to volume
        b. Compare entropy according to temperature
        c. Compare entropy according to molar mass
        d. Compare entropy according to phase change
        e. Compare entropy after mixing
        f. Compare entropy after chemical reactions
    2. The second law of thermodynamics
        a. Predict spontaneity based on the change in entropy of the universe

3. The third law of thermodynamics
   a. Explain why the molar entropies of any elements or compounds are positive values.
   b. Calculate the standard entropy change of reactions.
4. Gibbs free energy
   a. Calculate the standard free energy change of reactions at 298 Kelvins according to the standard free energy of formation
   b. Calculate the standard free energy change of reactions at any temperature according to the standard enthalpy change of the reaction and the standard entropy change of the reaction
5. Spontaneity
   a. Predict spontaneity according to the sign of enthalpy change, the sign of entropy change and the absolute temperature
   b. Calculate the temperature at which the system is at equilibrium under standard conditions.

III. Solutions
1. Electrolytes
   a. Identify strong electrolytes.
   b. Identify weak electrolytes.
   c. Identify nonelectrolytes.
2. Convert between various units of solution concentrations
   a. Calculate molality
   b. Calculate mole fraction
   c. Calculate ppm
   d. Convert between mass percent and molality or molarity
3. Colligative properties
   a. Calculate vapor pressure when solute is nonvolatile
   b. Calculate vapor pressure when solute is volatile
   c. Calculate boiling point elevation by nonelectrolytes
   d. Calculate boiling point elevation by electrolytes
   e. Calculate freezing point depression by nonelectrolytes
   f. Calculate freezing point depression by electrolytes

IV. Equilibrium
1. What are chemical equilibria
   a. Explain that reactions reach chemical equilibrium when forward reaction rate equals reverse reaction rate.
   b. Explain why the concentration of each reactant/product stops changing when reactions reach chemical equilibrium.
   c. Explain why a reaction can reach equilibrium from either the forward or reverse direction.
2. The nature of equilibrium constant
   a. Explain why equilibrium constant is affected by temperature, but not by concentrations.
   b. Relate equilibrium constant to the standard free energy change of the reaction.
3. The form of equilibrium constant

      a. Write the expression of K for homogeneous equilibria
      b. Relate K_p to K_C for gaseous equilibria
      c. Write the expression of K for heterogeneous equilibria
      d. Manipulate K according to how equations are manipulated

4. Equilibrium calculations
      a. Calculate K or Q according to their mass action expressions.
      b. Calculate K by ICE approach
      c. Calculate equilibrium concentrations by ICE approach

5. Direction of spontaneity
      a. Determine the direction of spontaneity by comparing Q with K

6. Le Chatelier's principle
      a. Identify the changes that can stress a system out of equilibrium
      b. Predict how a system restore equilibrium when Q changes
      c. Predict how a system restore equilibrium when K changes

V. Solubility equilibria

1. Solubility
      a. Write the expression of K_{sp}
      b. Convert between K_{sp} and solubility
      c. Calculate solubility under common ion effect

2. Precipitation
      a. Determine if precipitation occurs by comparing Q with K_{sp}

VI. Acid-base equilibria

1. pH and pOH
      a. Concert between hydronium ion concentration and hydroxide ion concentration
      b. Concert between ion concentration and pH/pOH
      c. Convert between pH and pOH
      d. Calculate pH of strong diprotic base solution

2. Bronsted-Lowry theory and Lewis theories
      a. Identify Bronsted-Lowry acids
      b. Identify Bronsted-Lowry bases
      c. Identify conjugate pairs
      d. Identify amphoteric species
      e. Identify Lewis acids and bases

3. Hydrolysis of salts
      a. Identify neutral salts
      b. Identify acidic salts
      c. Identify basic salts

4. Relative strength of acids
      a. Compare the strength of acids or bases according to the values of Ka or Kb
      b. K_a of an acid = K_w / K_b of its conjugate base
      c. Compare the strength of binary acids
      d. Compare the strength of ternary acids

5. Ionization calculations
      a. Compare the acidity of solutions according to K_a

      b. Calculate pH of a weak acid/base solution
      c. Calculate percent ionization
6. Polyprotic acids
      a. Simplify calculation of the pH of a polyprotic acid solution based on the stepwise ionization mechanism.
      b. Simplify calculation of the concentration of conjugate bases of a polyprotic acid due to its stepwise ionization.
7. Buffers
      a. Identify buffers.
      b. Calculate pH of buffers.
      c. Compare buffer capacities.
8. Titrations
      a. Find equivalence point.
      b. Calculate pH before equivalence point of strong-strong titrations.
      c. Identify titration curves.

VII. Electrochemistry
1. Redox chemistry
      a. Identify what is reduced/oxidized
      b. Identify what is reducing/oxidizing agent
2. Balance redox reactions according to half-reaction method
      a. Balance aqueous redox reactions under acidic conditions
      b. Balance aqueous redox reactions under basic conditions
3. Galvanic cells
      a. Describe the function of anodes
      b. Describe the function of cathodes
      c. Describe the function of salt bridges
      d. Describe the function of outer circuit
4. Cell notations
      a. Given cell notation, identify what's reduced/oxidized
      b. Given a redox reaction equation, write the cell notation
5. Standard cell potential and standard electrode potential
      a. Calculate standard cell potential according to standard electrode potential
      b. Predict spontaneity under standard conditions according to standard cell potential
      c. Compare strength of reducing/oxidizing agent according to standard electrode potential
      d. Choose a metal for cathodic protection
6. Cell potential and redox spontaneity
      a. Relate the sign of standard cell potential to the range of K or the sign of standard free energy change of the reaction
      b. Calculate standard free energy change of reactions according to standard cell potentials
      c. Calculate K according to standard cell potential
      d. Relate the sign of cell potential to the sign of free energy change of the reaction or redox spontaneity

                  e.   Apply Nernst equation to calculate cell potential

VIII.   Kinetics
1. What is reaction rate
    a. Calculate average reaction rate
    b. Convert between expressions of reaction rate with different substances according to reaction stoichiometry
2. Rate law
    a. Determine rate law
    b. Derive units of rate constant according to overall reaction orders
    c. Calculate how reaction rate changes when concentrations change
3. Integrated rate law
    a. Calculate according to Zero-order integrated rate law
    b. Calculate according to first-order integrated rate law
    c. Calculate according to second-order integrated rate law
4. Collision theory
    a. Relate activation energy to reaction rate
    b. Relate activation energy to enthalpy change of the reaction
    c. Use collision theory to explain why temperature affects reaction rates
    d. Use collision theory to explain why concentrations affects reaction rates
5. Reaction mechanisms
    a. Identify the number of elementary steps, the number of intermediates, the number of transition states, the rate-limiting step, and whether the reaction is exothermic or endothermic according to reaction profile.
    b. Given a reaction mechanism, derive overall reaction equation
    c. Given a reaction mechanism, identify reaction intermediates
    d. Given a reaction mechanism, determine rate law
6. Catalysis
    a. Explain how catalysis works
    b. Given a reaction mechanism, identify catalysts

IX.   Nuclear chemistry
1. Nuclear structure and stability
    a. Describe nuclear structure
    b. Describe band of stability
2. Nuclear reactions
    a. Compare nuclear reactions with chemical reactions
    b. Balance nuclear reactions
3. Nuclear decay
    a. Balance nuclear decay equations
    b. Apply first order kinetics of nuclear decay to do radiometric dating

Textbook

Chemistry: Atoms First The textbook is available in web view and PDF for free. The web view is recommended when you are online, because the embedded hyperlinks work seamlessly on any device. The PDF is for you to browse when you are offline.

Course material on Canvas

All course materials are posted on Canvas in Chem 1420.403. You do NOT need to purchase textbooks or homework programs for this course.

Resources

PLTL sessions

Peer-Led Team Learning (PLTL) leaders are undergraduate students that have taken the course before and excelled in it. They will hold multiple tutoring sessions each week to answer questions on recitations quizzes and PLTL quizzes. Dr. Liu meets with the PLTL leaders weekly to go over the recitation and PLTL quiz of the week. I highly recommend you try out the program for assistance. The schedule and location of PLTL sessions will be posted on Canvas in the top module "Learning Support" by the end of Week 1 after the leaders finalize their own schedule.

Chemistry Resource Center

This is free tutoring provided by graduate students in the chemistry department and located in the chemistry building (CHEM 231). It is open from Monday to Friday from 8 AM to 6 PM except for Thursday, which closes at 3-4:30 PM for the Seminar. For questions or comments about the CRC, please contact chemistry@unt.edu or 940-565-3524. You can check out more details at https://chemistry.unt.edu/undergraduate/instructional-resources.html

How to study for this course

All course contents are distributed into 26 lectures. For each lecture, I provide 1 or 2 or 3 sections of reading posted above the corresponding lecture page on Canvas. In each lecture page, the lecture PowerPoint, a homework quiz, a recorded live lecture and the link to the corresponding section in the free e-textbook are embedded. After every other lecture, a recitation quiz is posted to review the important topics covered in the previous two lectures. I recommend you read the sections posted on Canvas before watching the recorded lecture. Print out the lecture PowerPoint slides to make it easier for you to take notes while watching the recorded lectures. Take the homework quiz after you watch the recorded lecture to gauge your understanding. Review the material by taking the recitation quizzes whenever they are provided. When you have questions, please reach out for assistance by going to my office hours, PLTL sessions or CRC.

The practice exams contain the same number of questions on the same topics and the same difficulty levels as the questions in real exams. You are supposed to use the practice exams as a study guide to prepare for exams. After you work through the practice exams, make sure you can correct your mistakes. You can do so by re-watching the corresponding recorded lectures, going to PLTL sessions, office hours, or CRC tutoring center. You have three attempts on each practice exam. Each attempt has a 60-minute time limit, the same as real exams. The key is shown after the last attempt. To study for the final exam, you need to review all four practice exams. The practice exams are not for credit.

Course Calendar

In the following table, the assignments due on the corresponding day are shown. "H" stands for homework quizzes. "R" stands for recitation quizzes. "E" stands for lecture exams. "P" stands for PLTL quizzes.

	Mon.	Tue.	Wed.	Thur.	Fri.	Sat.
Week 1		H1	R1	H2		
Week 2		H3	R2	H4		P1
Week 3		H5	R3	H6		P2
Week 4		H7	P3, R4	E1		
Week 5		H8	R5	H9		P4
Week 6		H10	R6	H11		P5
Week 7		H12	R7	H13		P6
Week 8		H14	P7, R8	E2		
Week 9		H15	R9	H16		P8
Week 10		H17	R10	H18		P9
Week 11		H19	P10, R11	E3		
Week 12		H20	R12	H21		P11
Week 13		H22	R13	H23		P12
Week 14		H24	R14	H25		P13
Week 15	HAPPY THANKSGIVING!					
Week 16		H26	P14, R15	E4		
Week 17	Final Exam					

Course Grade Breakdown

Assignment Groups	Group Weight
Lecture Exams (drop the lowest)	45%
Final Exam	35%
Homework	10%
Recitation Quizzes	5%
PLTL Quizzes	5%
Total	100%

How to Calculate Your Overall Grade

Your overall grade is a weighted average of the percentage you get on each type of assignment. When you multiply the percentage you get on a type of assignment by the weight of the group, the result is the percentage points you get on this group of assignment. When you sum up the percentage points you get on each group, it is the overall percentage you get on this course.

For example, if Michael received 85% on lecture exams, 75% on final exam, 95% on homework, 90% on recitation quizzes and 95% on PLTL quizzes, the overall percentage Michael got in this course would be calculated as follows.

85% * 45% + 75% * 35% + 95% * 10% + 90% * 5% + 95% * 5% = 83.25%

Grading Scale

900 - 1000	A
800 - 899	B
700 - 799	C
600 - 699	D
< 600	F

I include two decimal places in the percentage number when I assign letter grades and look for a natural break when I decide on the cut-off value. In the following series of numbers - 90.00, 89.99, 89.89, 89.79, 89.49, 89.39, 89.29 - the natural break is at 89.79/89.49. Hence, in this example 89.79 and above gets an A. ***Note that these numbers are just given as an example. It does NOT mean that the cut off value between A and B for this semester is 89.79. To be fair to everyone, I won't reply to email requests to bump up grades.***

Grading Policy on Each Type of Assignment

Excusable Absences

Excusable absence includes recognized religious holy days, participation in official university functions such as student athlete events, pregnancy and parenting, required military service, and medical or other emergency. The excusable absence policy applies when you request a make-up lecture exam or extension on homework assignments.

Lecture Exams

Lecture exams weigh up to 45% of your overall grade. The lowest out of the four lecture exams will be dropped. Make-up exams are only granted if it is an excusable absence with written proof. If you missed an exam because you forgot about it, remembered the wrong date, overslept, or was too tired to take it, make-up exams will not be given. Everyone drops the lowest lecture exam, and this can be your dropped lecture exam.

Exams	Scope	Date	Location	# of questions	Time allowed
Exam 1	Lecture 1-7	9/11 Thur.	Sage 230	20	60 mins
Exam 2	Lecture 8-13	10/09 Thur.	Sage 230	20	60 mins
Exam 3	Lecture 14-19	10/30 Thur.	Sage 230	20	60 mins
Exam 4	Lecture 20-26	12/04 Thur.	Sage 230	20	60 mins
Final Exam	Lecture 1-26	12/08 Mon.	Sage 230	70	120 mins

Final Exam

The final exam is cumulative and weighs up to 35% of your overall grade. The final exam *__CANNOT__* be dropped. There is *NO* make-up exam for the final.

Homework quizzes

One homework quiz is provided for each of the 26 lectures. Each homework quiz is due on Tue or Thur. It is crucial that you keep up with the vigorous pace of the course. I set the due dates of all assignments for you to gauge if you are on schedule. There is a 10% late penalty per day if you submit a homework quiz after the due date. Extensions on homework assignments are only granted upon receiving written proof.

Three attempts are given and there is no time limit on any attempt. Some homework quizzes contain different questions in each attempt, while others contain the same questions in each attempt. If a homework quiz contains the **same** questions in each attempt. The key is revealed after the last attempt. If a homework quiz contains **different** questions in each attempt. The key is revealed after each attempt. Homework weighs up to 10% of your overall grade.

Recitation Quizzes

Each recitation quiz reviews the material covered in the previous two lectures. Each quiz is due on Wed. of the week. reach out to the PLTL leaders when you have questions. You have only one attempt at each quiz with unlimited time. If it's not finished in one sitting, you do NOT need to submit the quiz. Just close the webpage and resume when you open the quiz again. The key will only be shown 10 minutes after the quizzes are due. When you see the key, an explanation of the key is provided for some of the questions. Recitation quizzes are up to 5% of your overall grade.

PLTL Quizzes

Each PLTL quiz reviews the material covered in the previous two lectures. Each quiz is due on Sat. of the week unless there is a Lecture Exam in that week. Multiple PLTL sessions are offered in the middle of the week by PLTL leaders to answer your questions. Attending PLTL sessions is NOT mandatory. You have only one attempt on each quiz. If it's not finished in one sitting, you do NOT need to submit the quiz. Just close the webpage and resume when you open the quiz again. The key will only be shown 10 minutes after the quizzes are due. When you see the key, an explanation of the key is provided for some of the questions. PLTL quizzes are up to 5% of your overall grade.

Incomplete Grades

Starting from Mon. of Week 13, you can request an incomplete grade only if you meet all three criteria:

1. You are passing the course at the time point when you request an incomplete grade.
2. You have a justifiable and documented reason beyond your own control (such as serious illness or military service) for not completing the work on schedule.
3. You have a specific date within a year by which you propose finishing the course work.

Getting Help

Technical Assistance

Part of working in the online environment involves dealing with the inconveniences and frustration that can arise when technology breaks down or does not perform as expected. Here at UNT we have a Student Help Desk that you can contact for help with Canvas or other technology issues.
UIT Help Desk: UIT Student Help Desk site (http://www.unt.edu/helpdesk/index.htm)

Email: helpdesk@unt.edu

Phone: 940-565-2324
In Person: Sage Hall, Room 130
Walk-In Availability: 8am-9pm
Telephone Availability:
- Sunday: noon-midnight
- Monday-Thursday: 8am-midnight
- Friday: 8am-8pm
- Saturday: 9am-5pm

Laptop Checkout: 8am-7pm
For additional support, visit Canvas Technical Help (https://community.canvaslms.com/docs/DOC-10554-4212710328)

Student Support Services

UNT provides mental health resources to students to help ensure there are numerous outlets to turn to that wholeheartedly care for and are there for students in need, regardless of the nature of an issue or its severity. Listed below are several resources on campus that can support your academic success and mental well-being:

- Student Health and Wellness Center (https://studentaffairs.unt.edu/student-health-and-wellness-center)
- Counseling and Testing Services (https://studentaffairs.unt.edu/counseling-and-testing-services)
- UNT Care Team (https://studentaffairs.unt.edu/care)
- UNT Psychiatric Services (https://studentaffairs.unt.edu/student-health-and-wellness-center/services/psychiatry)
- Individual Counseling (https://studentaffairs.unt.edu/counseling-and-testing-services/services/individual-counseling)

Other student support services offered by UNT include
- Registrar (https://registrar.unt.edu/registration)
- Financial Aid (https://financialaid.unt.edu/)
- Student Legal Services (https://studentaffairs.unt.edu/student-legal-services)
- Career Center (https://studentaffairs.unt.edu/career-center)
- Multicultural Center (https://edo.unt.edu/multicultural-center)
- Counseling and Testing Services (https://studentaffairs.unt.edu/counseling-and-testing-services)
- Pride Alliance (https://edo.unt.edu/pridealliance)

- UNT Food Pantry (https://deanofstudents.unt.edu/resources/food-pantry)

Academic Support Services
- Academic Resource Center (https://clear.unt.edu/canvas/student-resources)
- Academic Success Center (https://success.unt.edu/asc)
- UNT Libraries (https://library.unt.edu/)
- Writing Lab (http://writingcenter.unt.edu/)
- MathLab (https://math.unt.edu/mathlab)

Chemistry Resources
- ***Chemistry Resource Center (CRC)***: It a dedicated Chemistry tutoring lab, staffed by chemistry graduate students.
- ***The Computational Chemistry Instructional Laboratory (CCIL)***: CCIL provides computer access to all undergraduate and graduate students enrolled in UNT chemistry courses. Computers are to be used only for chemistry related work and instruction. The CCIL is staffed by chemistry graduate students knowledgeable in the area of computational chemistry.

More information about CRC and CCIL can be found at this website (https://chemistry.unt.edu/undergraduate-program/instructional-resources).

UNT POLICIES

COVID-19
If you test positive for COVID, I would like to refer you to the current CDC Guidelines (https://www.cdc.gov/coronavirus/2019-ncov/index.html). You will need to provide documentation of a positive test and/or medical treatment in order to meet UNT's Student Attendance & Authorized Absence policy. Please visit the Dean of Students if you need assistance documenting authorized absences due to COVID or any other allowed reason.

Class Recordings & Student Likenesses
My lectures and notes are protected by state common law and federal copyright law. You are authorized to take notes in class thereby creating a derivative work from my lecture, but you are not authorized to make those notes available to anyone outside of your section. You may record my lectures, but you are not authorized to share that recoding with anyone outside of your section.

Academic Dishonesty
Students caught cheating or plagiarizing will receive a "0" for that particular assignment or exam. Additionally, the incident will be reported to the Office of Academic Integrity, who may impose further penalty. According to the UNT catalog, the term "cheating" includes, but is not limited to: (a) use of any unauthorized assistance in taking quizzes, tests, or examinations; (b) dependence upon the aid of sources beyond those authorized by the instructor in writing papers, preparing reports, solving problems, or carrying out other assignments; (c) the acquisition, without permission, of tests or other academic material belonging to a faculty or staff member of the university; (d) dual submission of a paper or project, or resubmission of a paper or project to a different class without express permission from the instructor(s); or (e) any other act designed to give a student an unfair advantage. The term

"plagiarism" includes, but is not limited to: (a) the knowing or negligent use by paraphrase or direct quotation of the published or unpublished work of another person without full and clear acknowledgment; and (b) the knowing or negligent unacknowledged use of materials prepared by another person or agency engaged in the selling of term papers or other academic materials.

Acceptable Student Behavior

Student behavior that interferes with an instructor's ability to conduct a class or other students' opportunity to learn is unacceptable and disruptive and will not be tolerated in any instructional forum at UNT. Students engaging in unacceptable behavior will be directed to leave the classroom and the instructor may refer the student to the Dean of Students to consider whether the student's conduct violated the Code of Student Conduct. The university's expectations for student conduct apply to all instructional forums, including university and electronic classroom, labs, discussion groups, field trips, etc. The Code of Student Conduct can be found at http://deanofstudents.unt.edu.

ODA Statement

The University of North Texas makes reasonable academic accommodation for students with disabilities. Students seeking reasonable accommodation must first register with the Office of Disability Access (ODA) to verify their eligibility. If a disability is verified, the ODA will provide you with a reasonable accommodation letter to be delivered to faculty to begin a private discussion regarding your specific needs in a course. You may request reasonable accommodations at any time, however, ODA notices of reasonable accommodation should be provided as early as possible in the semester to avoid any delay in implementation. Note that students must obtain a new letter of reasonable accommodation for every semester and must meet with each faculty member prior to implementation in each class. Students are strongly encouraged to deliver letters of reasonable accommodation during faculty office hours or by appointment. Faculty members have the authority to ask students to discuss such letters during their designated office hours to protect the privacy of the student. For additional information, refer to the Office of Disability Access website at http://www.unt.edu/oda. You may also contact ODA by phone at (940) 565-4323.

Emergency Notification and Procedures

UNT uses a system called Eagle Alert to quickly notify you with critical information in the event of an emergency (i.e., severe weather, campus closing, and health and public safety emergencies like chemical spills, fires, or violence). The system sends voice messages (and text messages upon permission) to the phones of all active faculty staff, and students. Please make certain to update your phone numbers at http://www.my.unt.edu. Some helpful emergency preparedness actions include: 1) know the evacuation routes and severe weather shelter areas in the buildings where your classes are held, 2) determine how you will contact family and friends if phones are temporarily unavailable, and 3) identify where you will go if you need to evacuate the Denton area suddenly. In the event of a university closure, please refer to Blackboard for contingency plans for covering course materials.

Retention of Student Records

Student records pertaining to this course are maintained in a secure location by the instructor of record. All records such as exams, answer sheets (with keys), and written papers submitted during the duration of the course are kept for at least one calendar year after course completion. Course work completed via the Canvas online system, including grading information and comments, is also stored in a safe electronic environment for one year. You have a right to view your individual record; however,

information about your records will not be divulged to other individuals without the proper written consent. You are encouraged to review the Public Information Policy and the Family Educational Rights and Privacy Act (FERPA) laws and the university's policy in accordance with those mandates at the following link: http://essc.unt.edu/registrar/ferpa.html